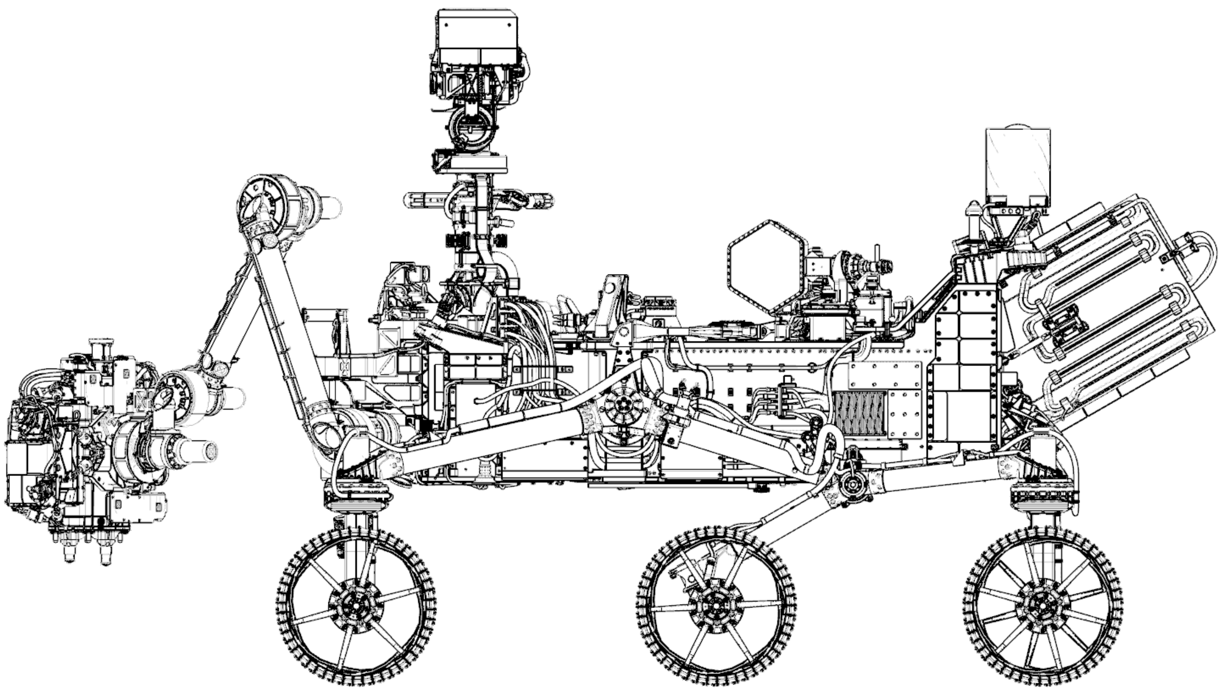
Mars 2020 Surface Mission Modeling

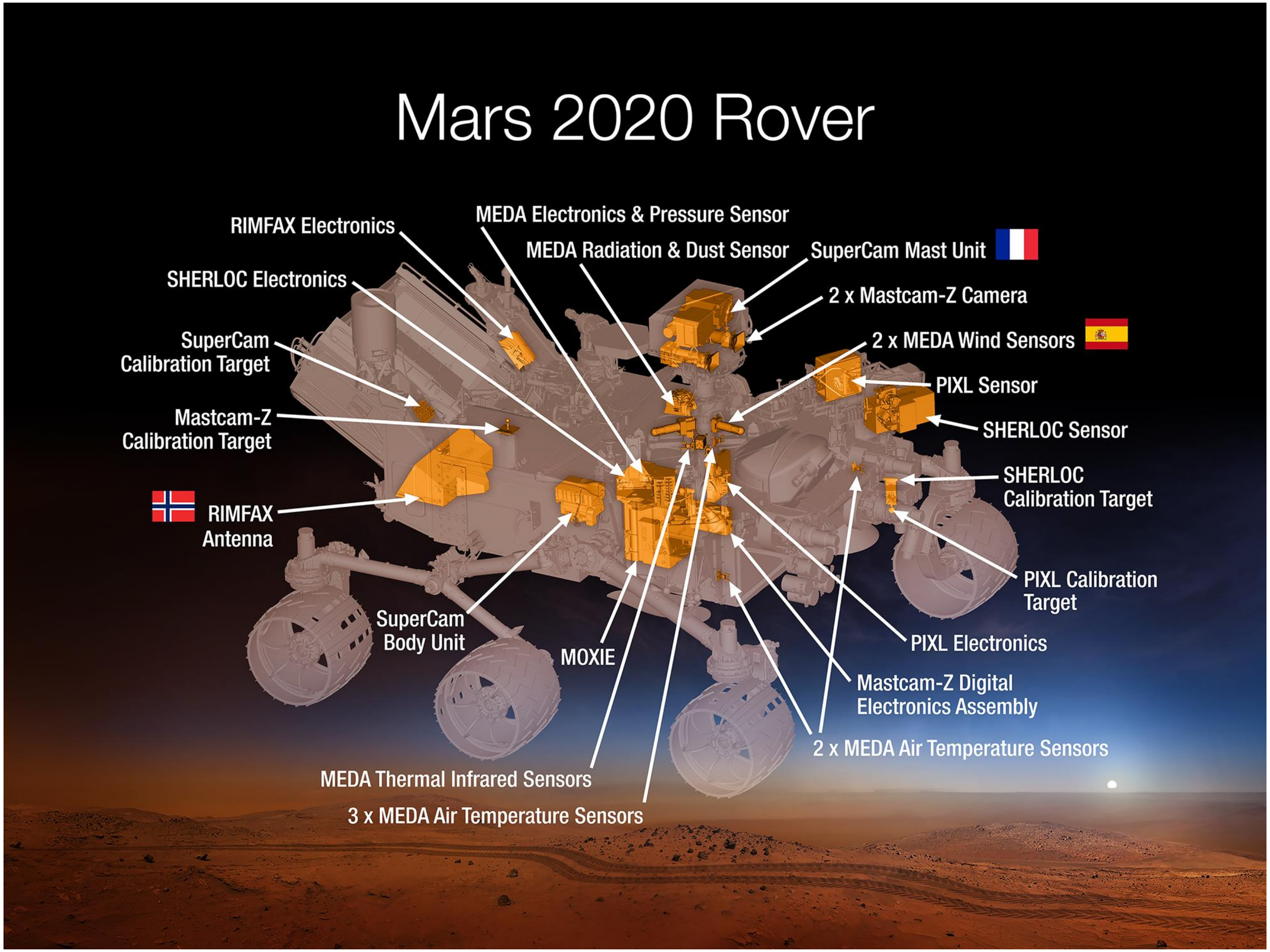
Landing Site Thermal Environments

Travis Wagner

Robert Lange



What is Mars 2020?



What Will Mars 2020 Do?

A. Characterize the processes that formed and modified the geologic record within a field exploration area on Mars selected for evidence of an astrobiologically relevant ancient environment and geologic diversity.

B. Perform the following astrobiologically relevant investigations on the geologic materials at the landing site. Determine the habitability of an ancient environment and for those interpreted to have been habitable, search for materials with high biosignature preservation potential.

C. Assemble rigorously documented and returnable cached samples for possible future return to Earth.

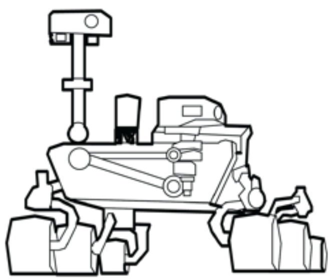
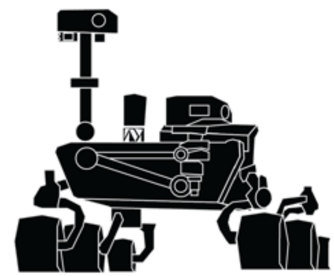
D. Contribute to the preparation for human exploration of Mars by demonstrating In-Situ Resource Utilization (ISRU) technologies to enable propellant and consumable oxygen production from the Martian atmosphere for future exploration missions.

Surface Mission Design Motivation

Jet Propulsion Laboratory
California Institute of Technology

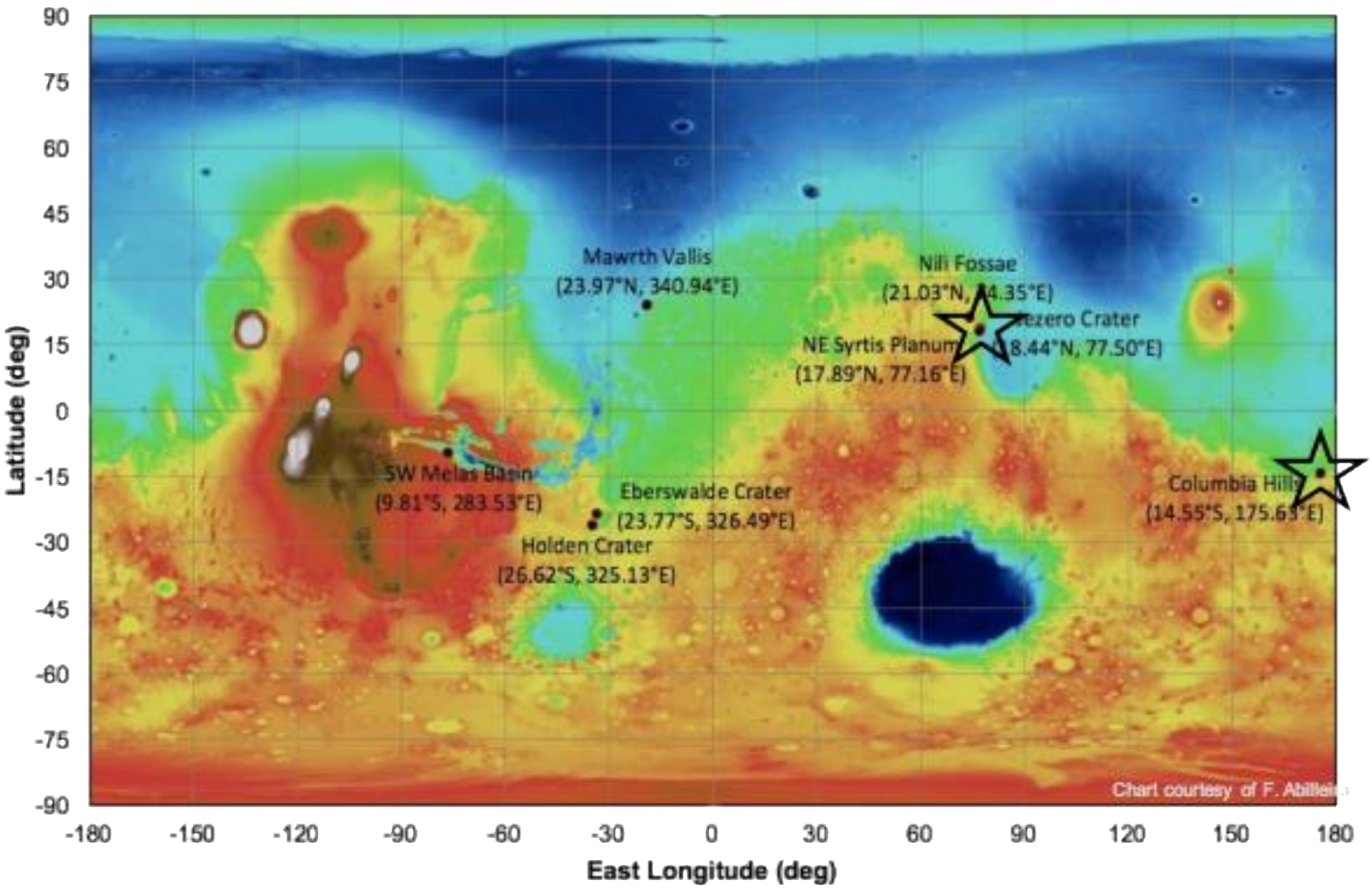
1.5 MARS YEARS

context

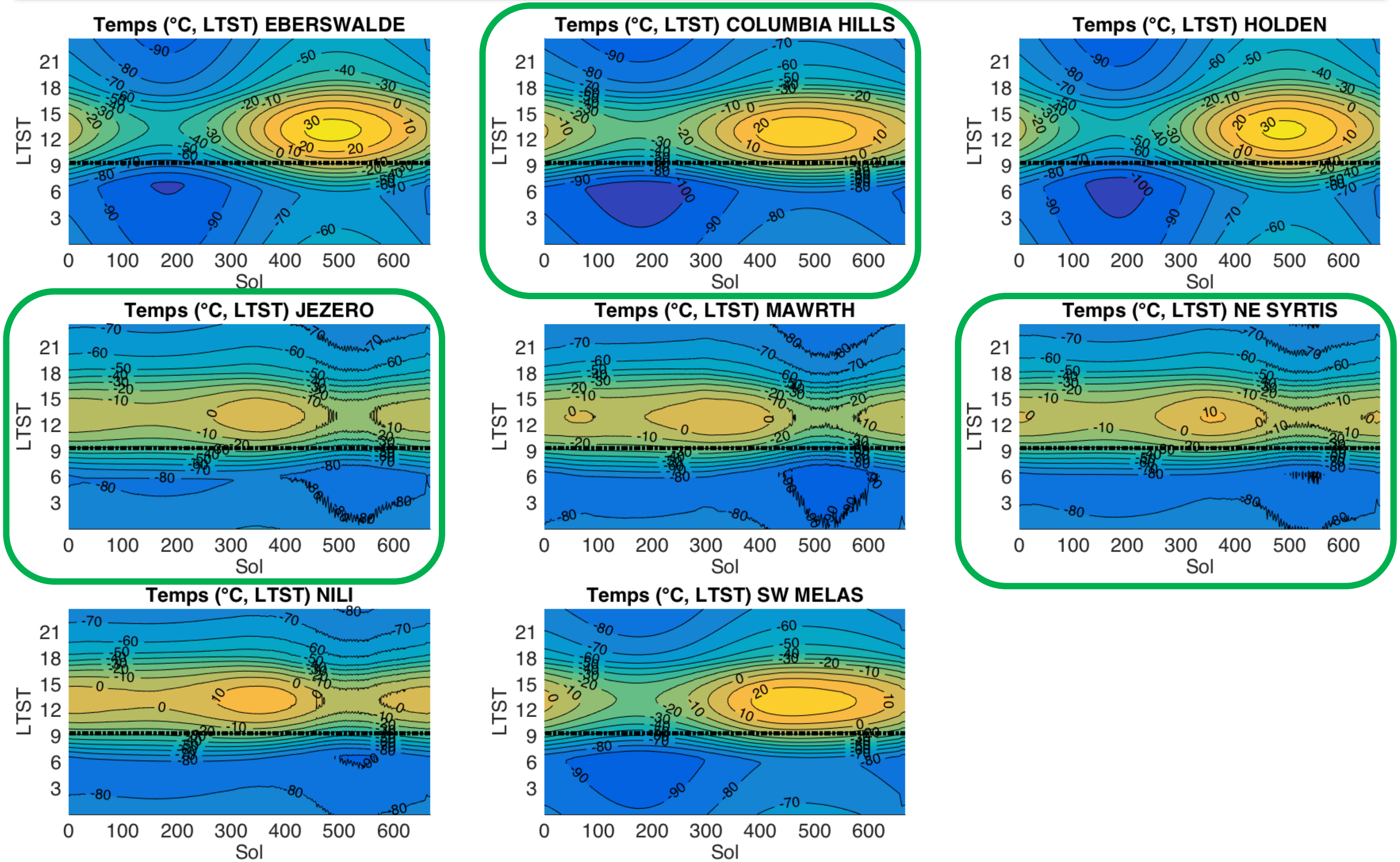
MSL	M2020
	
MARS YEARS: **1.5**	MARS YEARS: **1.5**
DISTANCE COVERED: **10.6 km**	DISTANCE TO COVER: **15 km**
SAMPLES COLLECTED: **2 scooped** **6 drilled samples**	SAMPLES TO COLLECT: **20 drilled samples**

MARS 2020 PROJECT

Where are the Landing Sites?



Site Thermal Environments are Distinct



The Problem

- Thermal modeling needs to be run on environment data to understand energy impacts
- Dataset is too large to run thermal modeling on everything

Ideas

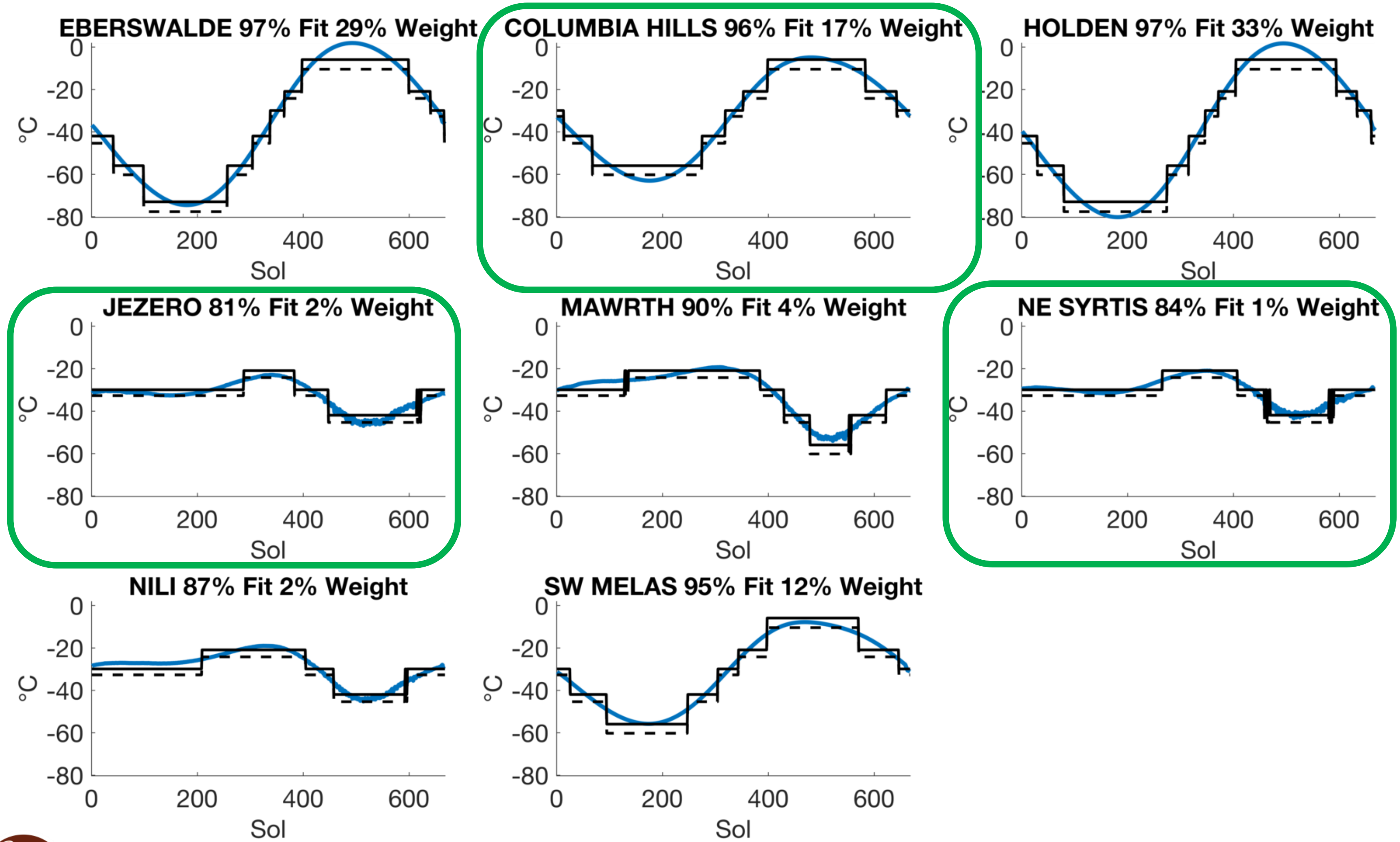
- Reduce the dataset down to a handful of representative environments (thermal bins)
- Describe site environments in terms of bins and sol ranges over which they apply
- Choose bins such that they fit the ground temperature data well across all sites while ensuring the site environments still look distinct

Optimization Strategy

- Ground temps sliced at 9:30 am LTST
- Formulated as a six-dimensional optimization problem with the goal to find $\vec{b} = \langle b_1, b_2, b_3, b_4, b_5, b_6 \rangle$
- Bins evaluated using R^2 fitness to the data and then multiplied by a weighting factor derived from site variance
- Additional details in paper…

Optimal Bins Found

Best Bins: -73, -56, -42, -30, -21, and -6 (ºC)

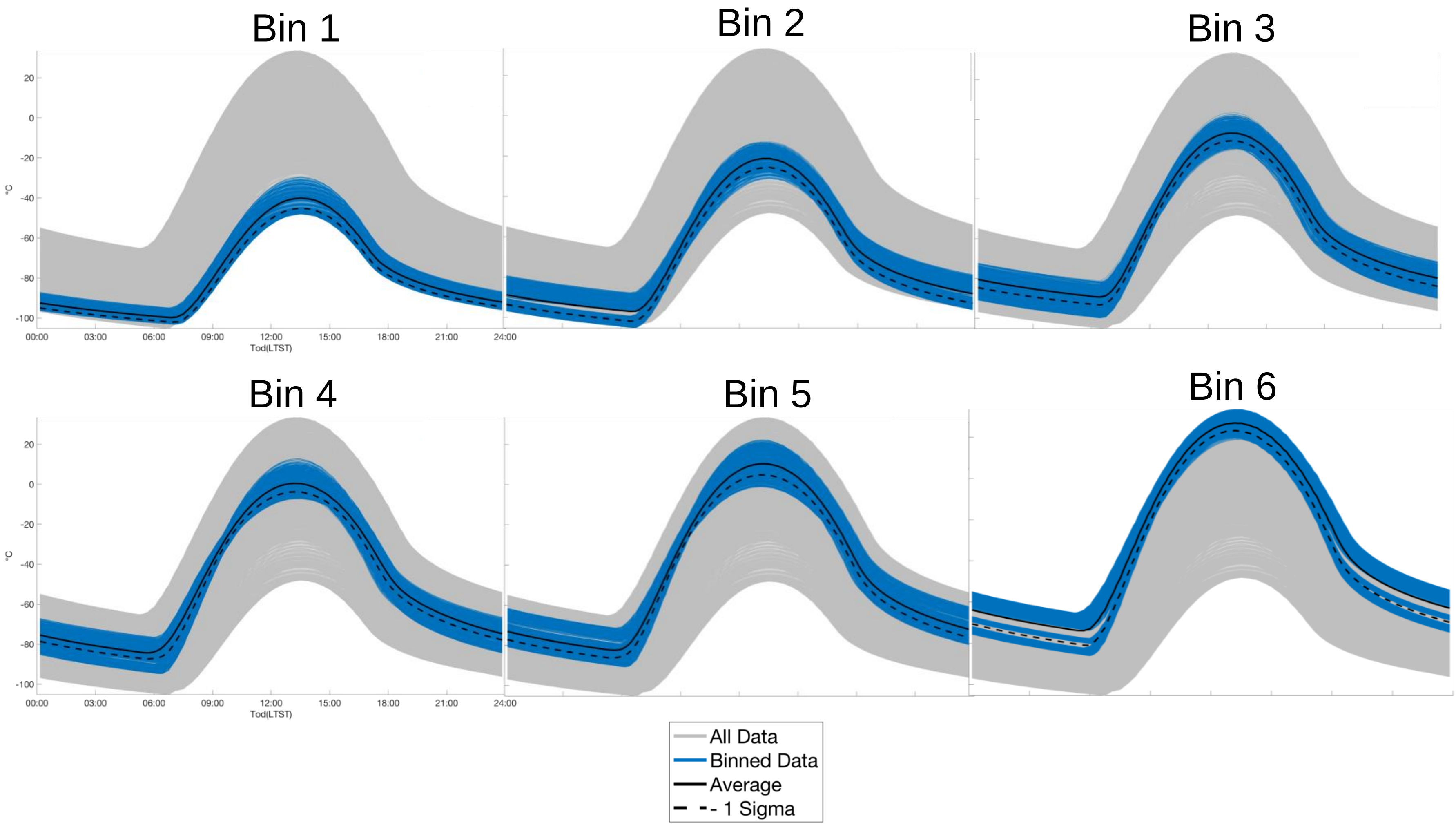


How Sites Use the Bins

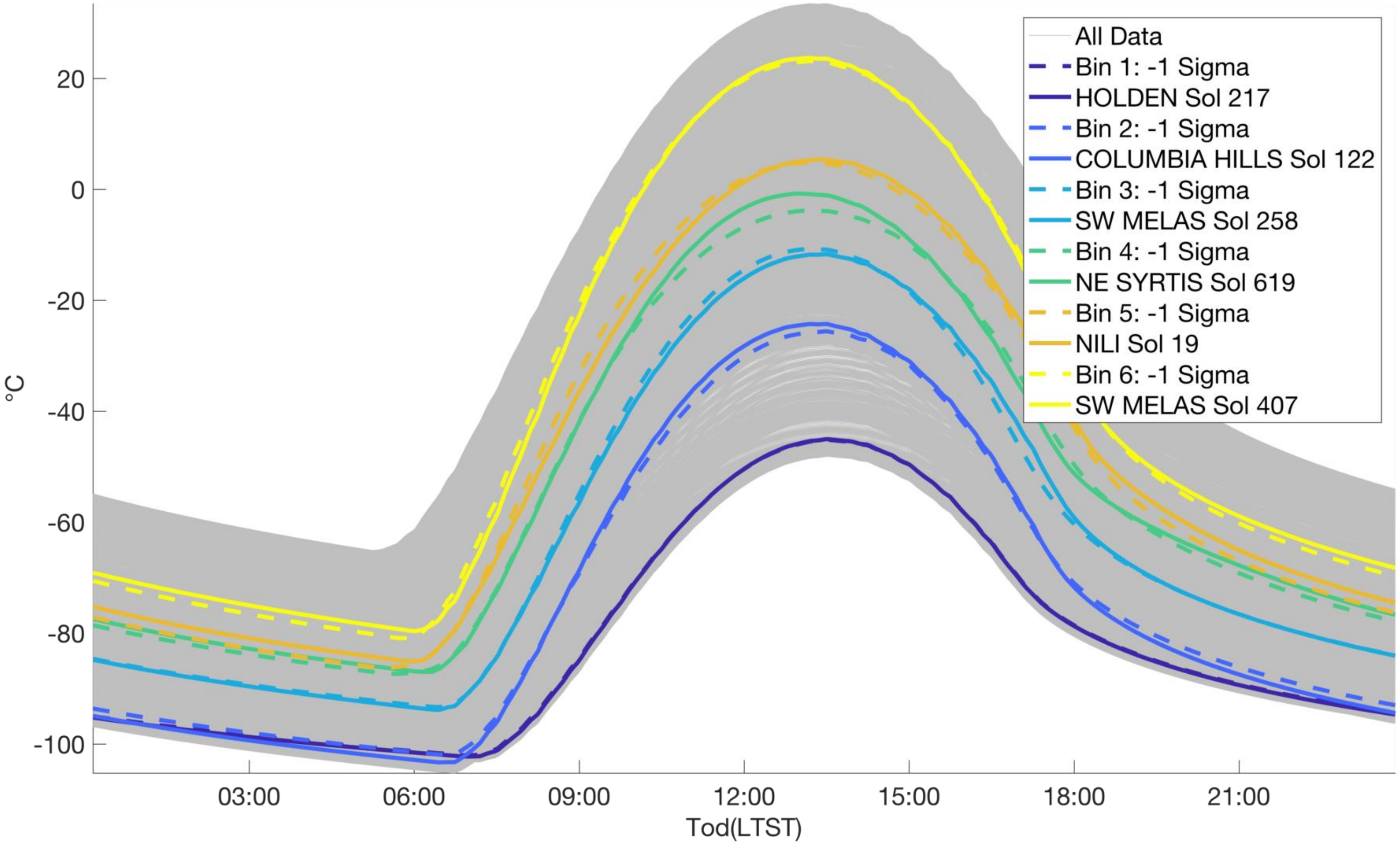
Percentage in Bin

Site Name	1	2	3	4	5	6
Eberswalde	24	16	11	8	11	30
Columbia Hills	0	31	14	11	16	28
Holden	29	14	10	8	11	28
Jezero	0	0	26	60	14	0
Mawrth	0	11	17	34	38	0
NE Syrtis	0	0	18	61	21	0
Nili	0	0	21	50	29	0
SW Melas	0	23	19	13	19	26

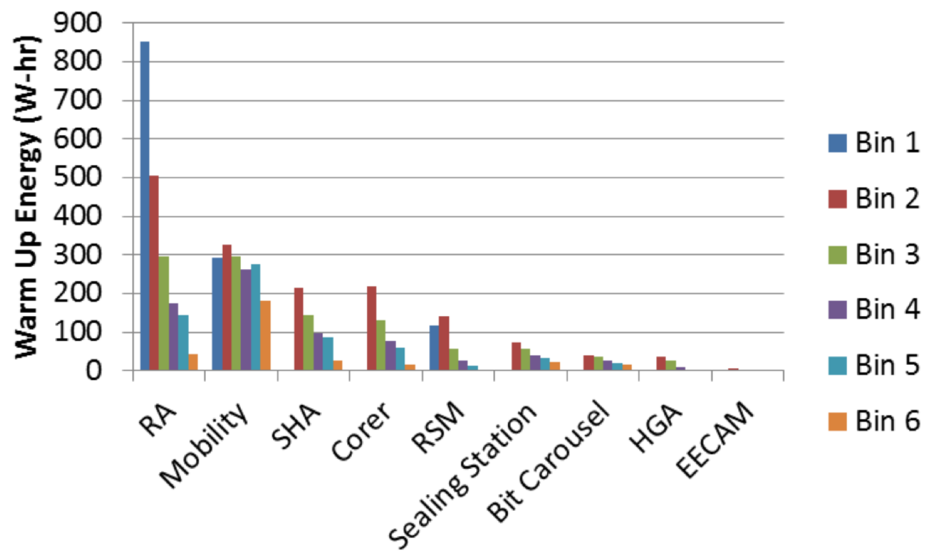
Bins are Well Grouped

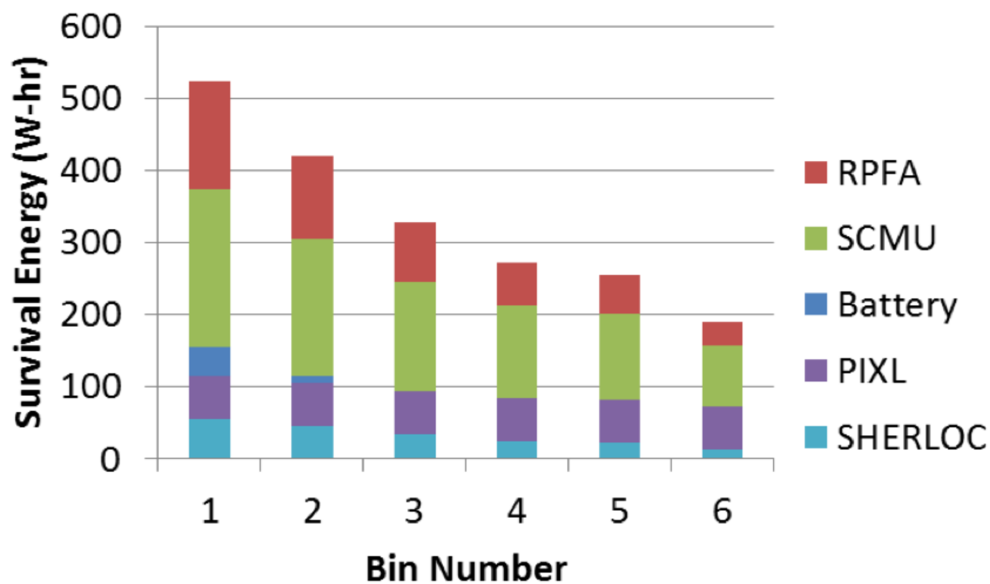


Matching Bins to the Dataset



Thermal Modeling Results



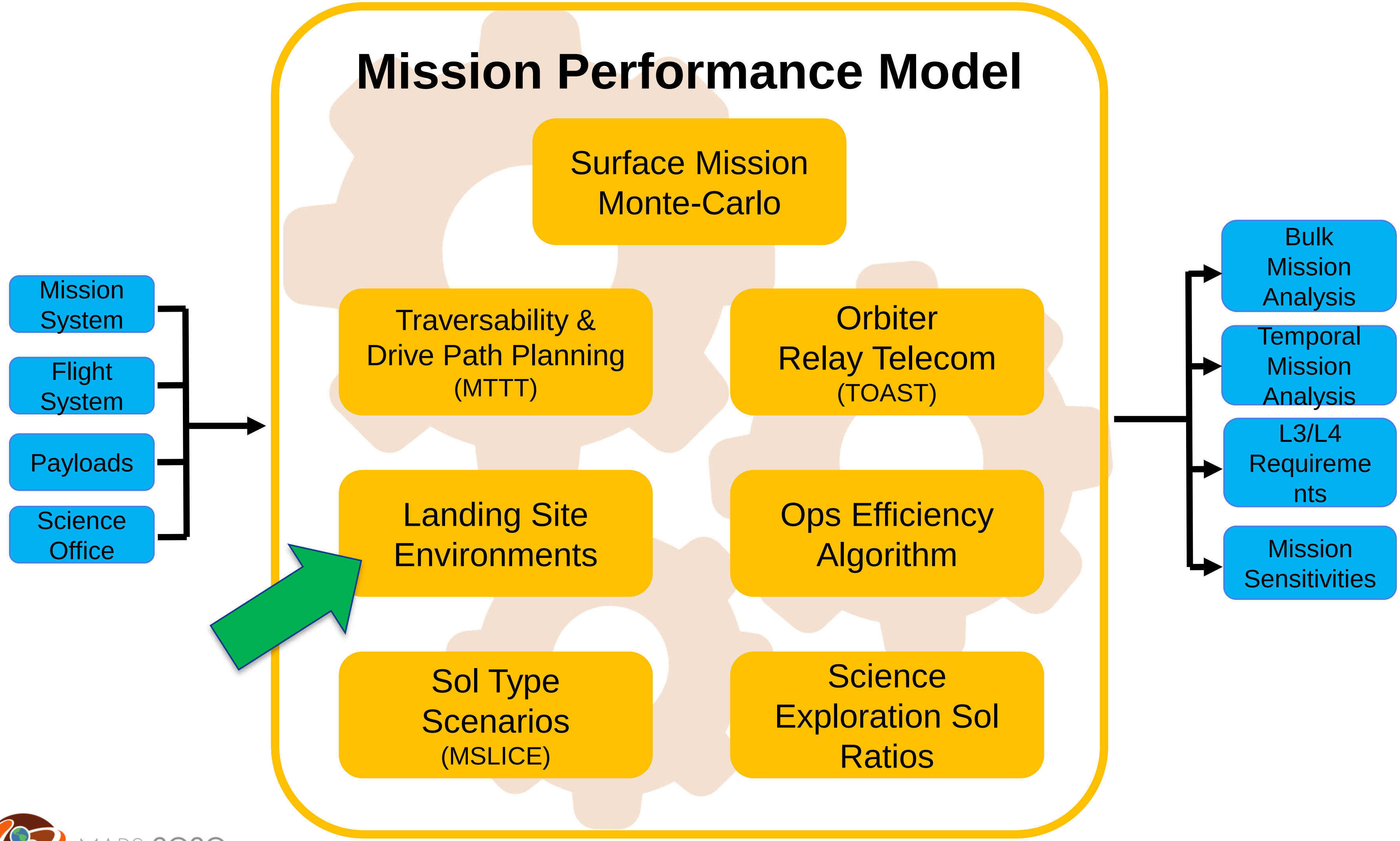


Subsytem Definitions

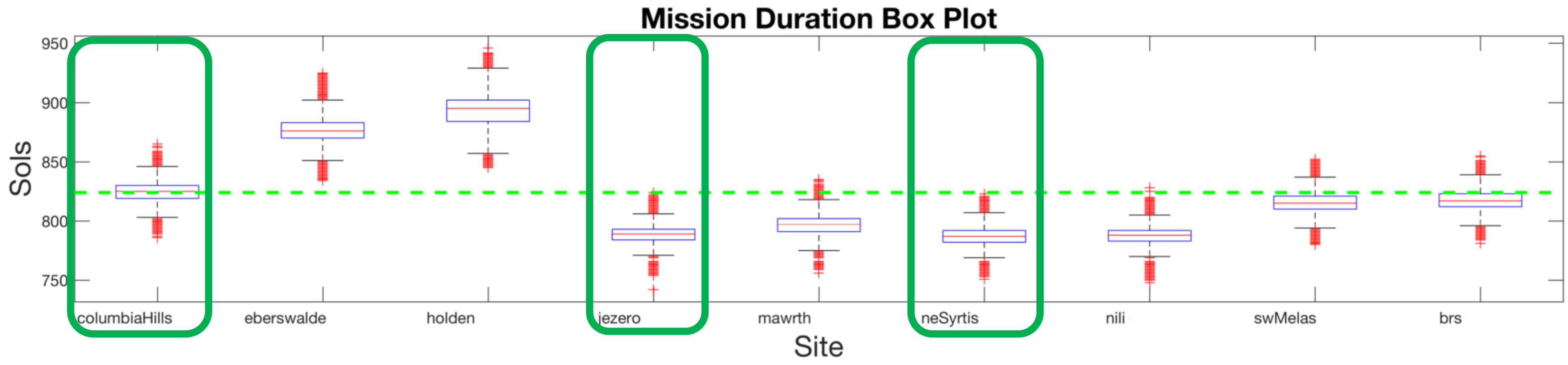
- **RPFA:** rover pyro fire assembly
- SCMU: SuperCam mast unit
- **PIXL:** arm mounted geologic spectrometer
- **SHERLOC:** arm mounted organic spectrometer
- **RA:** rover arm
- **SHA:** sample handling arm
- **RSM:** remote sensing mast
- **HGA:** high gain antenna
- **EECAM:** engineering cameras

MARS 2020
PROJECT

Small Part of Mission Model



Mission Durations of Sites are Distinct



Conclusions

- Dataset reduced down to six bins
- Bins fit site environments well
- Sites still look distinct and end up with different mission duration performance
- Bin populations are well grouped across all sites

Lessons Learned

- Data reduction strategies can be instrumental to the mission design process
- If an optimization algorithm gives nonideal results, maybe it’s answering the wrong question